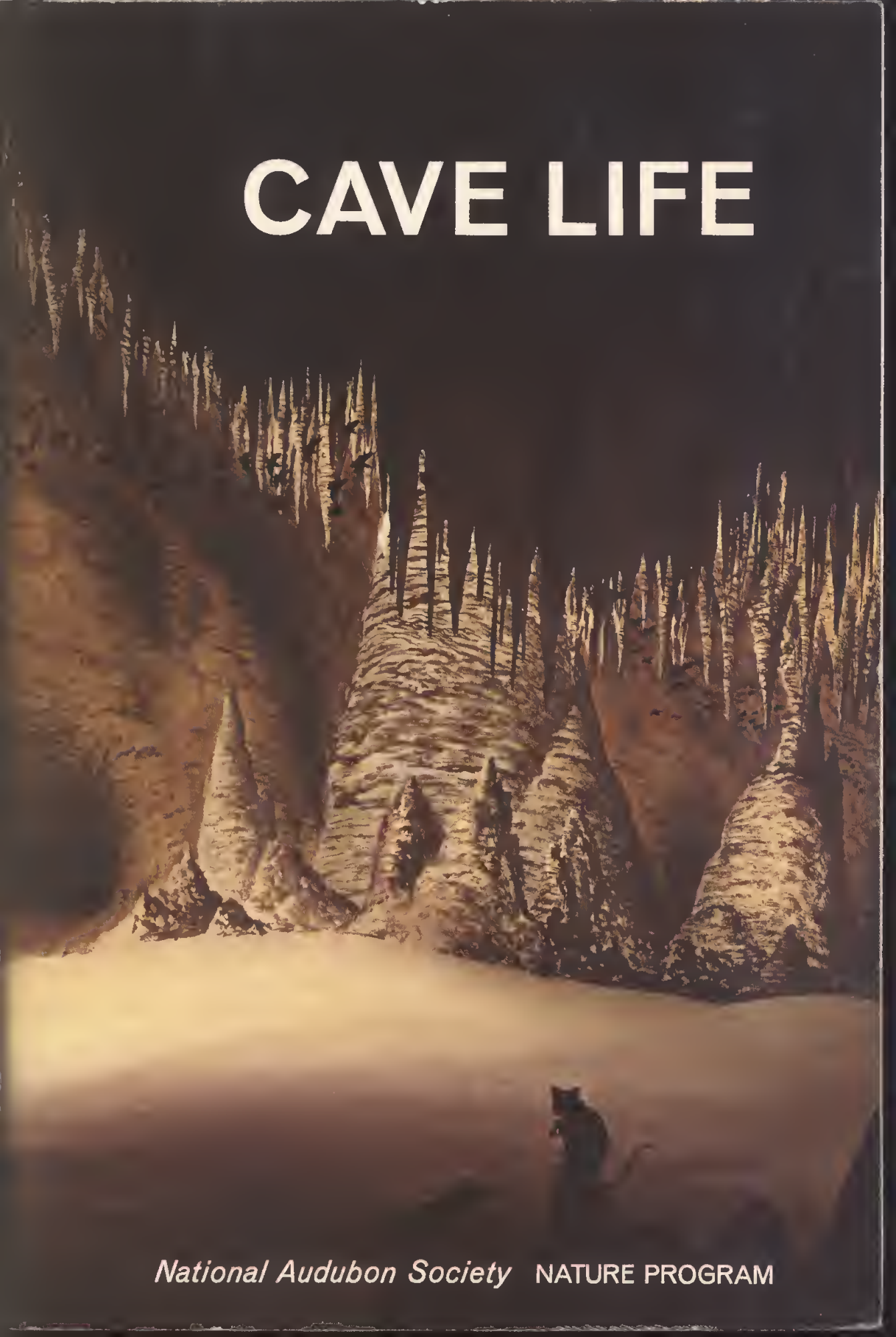
CAVE LIFE



National Audubon Society NATURE PROGRAM

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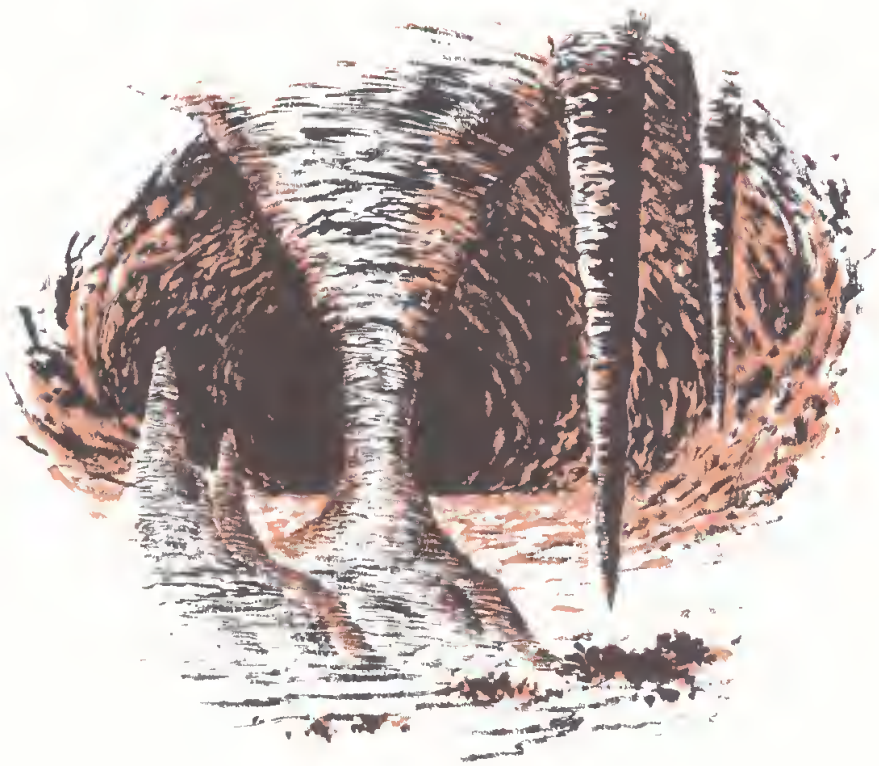
CAVE LIFE



by

CHARLES E. MOHR

and RUSSELL GURNEE

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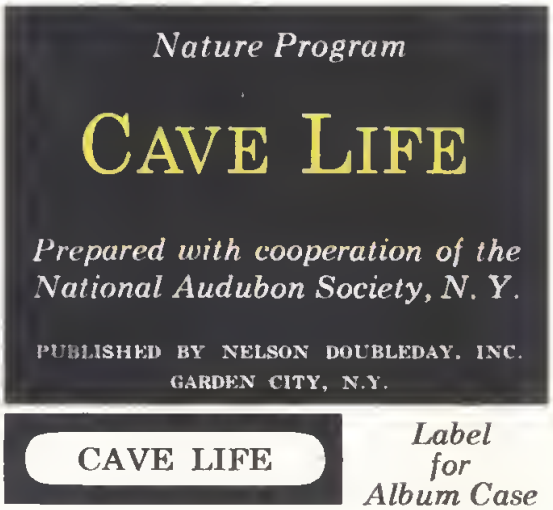
Nature Program
CAVE LIFE
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IF WE COULD TRAVEL around the earth by satellite and look down at the surface, we would be able to distinguish mountains, lakes, deserts and major rivers. As we sped around in our satellite, itself only a speck compared with the earth, we would pass over jungles, deserts and ice pack apparently uninhabited and unexplored. But we know that most of the land surface actually has been explored, mapped and photographed. All of the highest mountains have been climbed, the islands named and the usable soil planted and developed.

Here we are on the threshold of the greatest unexplored area of all, outer space, and yet as we flash over the land below we wonder—have we thoroughly explored all this land? Do we really know much of the sea which covers three-quarters of the earth? Is that wrinkled surface below, made up of mountains and valleys, all there is to know of our land? Is it possible that there are places never before seen by man, never explored or even imagined? Yes! Beneath some of the land below there are underground galleries fashioned by nature larger than our greatest cathedrals, some as beautiful as any spectacle on earth. Hundreds of thousands of caves are scattered throughout the world, partially explored, and for all our knowledge, equipment and centuries of exploration, perhaps thousands more are undiscovered and unexplored.

Let's select a landing site for our satellite, take off our space suits with their electronic aids, and walk out into the country that we so swiftly passed over only minutes ago.

Here is one of the little valleys that was just a flash of green in our orbit; now we see it as a broad green meadow stretching between two high ridges. A stream flows across the meadow, twisting and winding, until it disappears into the opposite ridge. Let's follow this stream and

20. INTERIOR OF CAVE, TRINIDAD

The ledges of this cave in Trinidad are used as roosts by the oilbirds. The floor is covered with weak shoots which sprout from the seeds dropped by the birds.

see what happened to it. As we walk through the tall grass toward the opposite ridge, we see that the stream enters a broad, high arched opening in the rocks. Peering into this open tunnel, our eyes are unable to see into the dark interior. As we wonder how far the tunnel extends, we think of all that we have heard and known about caves.

Before we enter this world without light—this strange yet appealing passageway—perhaps we should pause and consider what we know about caves in general.

Dark and mysterious, cold and forbidding—these are some of the things that may come to your mind when you think about caves. Prehistoric man may have felt the same way; yet once he used these shelters provided by nature as a protection from the wind, cold and rain.

The winter winds and snows drove him into dark recesses in the rocks where the temperature stayed constant; and he learned of another world where there was no light and only the sound of water broke the stillness.

Somehow in that distant past man discovered how to make fire, and with that knowledge he made torches and explored some of the underground which was so close but unknown. He did find it dark and mysterious, but the light and heat of his lamps took away the fear and he saw only stone and dirt. Turning his back on the caves, he took his torch and went out into the other world and began his long climb to be the man we know today.

During the thousands of years it took man to progress from using the stone axe to using atomic power, caves have remained nearly the same. Today we can go back into the same rooms and chambers visited by prehistoric man and see his handprints and markings on the walls, ceilings blackened with the smoke of his torches, and his footprints in mud—still plastic after 20,000 years. These things tell of the activities of our ancestors, stopped for a brief moment as surely as a photograph today catches a scene on paper.

Each species of animal has adapted to its environment. This young horseshoe bat, found in the Batu Caves, Malaya, will soon develop into a strong flier. He will use the special equipment he has inherited—his leaf nose and cup-shaped ears—to aid him in locating food in the dark by means of sonar.

16. BUSHMAN CAVE, SOUTH AFRICA

This cave was used by nomadic bushmen in the Orange Free State of South Africa. These people are a rare example of cultural retrogression.

What are these caves that seem never to change? Where are they located? How were they made and what can we learn from these museums so strange to our eyes?

These are some of the questions still asked today by scientists and students alike. We will try to answer some of them, but many will require much more study and research before all the answers are known.

How Caves Are Made

CAVES ARE FOUND on every continent in the world and in nearly every country. They are all different, and each one has its own story to tell. Nearly all caves have been formed by water. The process

by which they are formed is fairly easy to understand, but the span of time and the size of the undertaking are much harder for us to comprehend.

Geologists, who study the earth, know that hundreds of millions of years were needed to make the mountains and hills which we see around us. The earliest life as we know it today was in the sea. Some of the shells, corals and even fish became embedded in the silt and mud of the sea bottom, and after millions of years the shapes and outlines of their forms were transformed into stone. These casts, called fossils, give us a record of the life which existed long before the mountains and valleys existed. In some cases the dry land over which we now walk was covered by the sea; what was once the mud and silt sea bottom is now solid rock thrust up by forces so tremendous that we cannot visualize their power.

This solid rock, made from sediment and millions of sea creatures, is known as limestone and is one of the earth's most abundant sedimentary rocks. It is nearly insoluble in pure water, but it will dissolve when water with even a slight amount of acid flows over it. Most of the water which makes caves comes from rain and has absorbed a little

Caves hollowed out of limestone were once used as dwellings by people living on Palmarola Island off the Italian coast near Anzio.

10. PALMAROLA ISLAND CAVES, ITALY

carbon dioxide from the air. This rain water, as it drains through decayed vegetation on the ground, becomes a weak solution of carbonic acid; as it seeps down through the cracks and crevices in the limestone, it dissolves a tiny bit of the stone in its path.

While stone may seem hard, under great pressures or chemical action it can become almost plastic. Earth-building processes have thrust ridges and mountains thousands of feet above the sea. But even stone cannot completely withstand this severe stress and, like a bar of taffy,

The origin of such bizarre formations as these in Ohio Caverns baffles even the mineralogist. At least it is no longer believed that they formed along spider webs or that air currents twisted them into such shapes.

12. ROCK HOUSE CAVERN, OHIO

Rock House Cavern in Rock House State Park, Hocking, Ohio, is an example of a cave fashioned out by water action.

many limestones shatter and split leaving thousands of cracks. These cracks or joints form major channels which allow the formation of caves by solution.

Caves Are Where You Find Them

SOME LIMESTONE AREAS of the world are so eroded that no water flows on the surface, and the streams and rivers flow through caves hundreds of feet beneath the surface. Such regions are known as "karst" areas, named for a region in Yugoslavia where there are perhaps thousands of caves.

Because limestone is so abundant, there are many karst regions of the world. Caves in limestone are not only the most numerous but also the largest in size. Two caves, Floyd Collins' Crystal Cave in Kentucky and Hölloch Cave in Switzerland, have more than forty miles of mapped passageways each. Carlsbad Caverns in New Mexico has what may be the largest single room in any cave in the world. It is 2,000 feet long and reaches to the height of a thirty-floor building. Most limestone caves are within several hundred feet of the surface, but occasionally the limestone has been lifted to great heights above sea level and the caves assume a vertical pit shape. Pierre Saint-Martin Cave in the Pyrenees Mountains in France is such a cave. The entrance drop is over 1,100 feet deep.

The deepest known cave is also in France—Berger Chasm—where speleologists have explored 3,000 feet below the surface.

Rock painting of "swimming stags" in the cave of Lascaux, France. The length of the frieze is sixteen feet four inches.

Heat Can Also Form Caves

NOT ALL CAVES are found in limestone. Long, sinuous caves are found in volcanic regions where the molten lava has boiled from the earth and flowed slowly but steadily over the ground. The outside of this river of liquid stone starts to cool and harden while the middle

7. McCALL GLACIER, ALASKA

A large snow-roofed crevasse called a bergschrund is often formed at the head of a glacier.

stays hot and flowing. When the central portion flows out, it leaves long passages. These "lava tubes" may extend for miles and be as large and as barren as the tunnels of an underground railway.

Nature Is a Sculptor

WIND, WATER AND SAND form a powerful combination which has made thousands of caves along the coasts of the world. Even the hardest rocks cannot withstand this pounding and abrasive action. On the island of Staffa off the Scottish coast is a remarkable sea cave carved out of solid basalt. Fingal's Cave, which can be entered by boat, has a high arched opening in the black rock. The action of water

and wind through the pillars and columns left from the prismatic structure of the rocks sets up wild echoes and tones throughout the cave. The early Celts, who called it the Harmonious Grotto, thought it was inhabited by spirits.

On the Isle of Capri, in Italy, the Blue Grotto has lured tourists for hundreds of years to see its interior lighted by the reflection of the sun through the blue water.

Some caves are formed by the splitting of the earth by volcanic action. These crevices, which usually extend to the surface, may be very deep, and are sometimes bridged over by fallen rock. In northern climates the winter snows remain in the bottoms of these cracks all year round. Some limestone caves which are open to the surface have permanent ice flows—glaciers within mountains—providing spectacular underground scenery.

Other caves are found entirely in ice. In the Antarctic, crevices in the ice pack extend down several hundred feet and are lighted by the sun filtering through the translucent walls.

19. ICE CAVE, ANTARCTICA

This ice cave was formed as an ice cap slowly moved outward from the top of a rocky hill in Antarctica, leaving a space between itself and the bedrock.

Dripping water will form draperies and ribbon-like formations. In tropical caves, such as this one in Malaya, formations are sometimes eroded away by the changing mineral content of the surface water. It is also possible that bacteria will affect formation growth.

The Story of a Drop of Water

WE HAVE SEEN how caves are formed by water eating away rock; but after nature has used water to eat the rock away, she also works to fill these openings up again. The same little drop which falls as rain flows through the soil, dissolves a tiny bit of limestone and may flow down deep below the surface and appear on the ceiling of one of the many limestone caves.

Let's follow this drop as it hangs quivering on the ceiling of this dark room. The drop falls because of the exposure to the air of the cave, the loss of some of its carbon dioxide, the relentless pull of gravity and the push of more water behind it. As it falls it leaves a minute quantity of calcium carbonate which it transported from above in its journey from the surface. Each drop that follows does the same. Millions upon millions of drops follow, each leaving its little ring of calcite one on the other until a tube of stone is formed called a stalactite (from the Greek "stalaktos", meaning oozing out in drops).

The first drop to fall might splatter on a stone underneath it. This

1. A CALIFORNIA SEA CAVE

At high tide a sea cave may be dangerous, if not impossible, to enter unless there is some access from the landward side.

violent action causes more loss of calcite and as each succeeding drop falls, a little mound of calcite builds up, forming a stalagmite. Under certain conditions these two formations grow to such a size that they join together as a column. Then the water flows down the sides making the formation thicker and thicker until it may completely fill a room.

An Underground Garden

THE SHAPES of formations are usually quite regular—the stalactites like carrots and the stalagmites like rounded candle stubs. Sometimes, though, nature creates some erratic crystalline growths which defy gravity and our attempts to explain them. These odd forms are called helictites. One of the most unusual formations of this kind is found in Sonora Caverns in the American state of Texas, where na-

ture by some caprice has fashioned a butterfly in stone. Other shapes may look like corkscrews or twisted rope. Sometimes walls and ceilings are covered with pointed crystals called "dogtooth spar".

Another odd formation is sometimes found under waterfalls or in pools of water. Pebbles or pieces of calcite which are stirred by constant water action will often grow rings of calcite as they endlessly rotate in shallow pools. The resulting little balls, called "cave pearls", sometimes grow to the size of baseballs.

There are other minerals also present in caves. Some of the most decorative forms of gypsum in its natural state are the "cave flowers"

Stalagmites build up directly beneath stalactites only if mineral-laden water percolates downward faster than it evaporates from the stalactites. The formations keep building toward each other and may eventually fuse into columns.

which are found in certain dry caves of the world. Traces of minerals and chemicals in the soil and rocks above a cave will provide hue and shading of the formations as they grow. Manganese, iron oxide, copper sulfate and others paint the walls, floors and formations with many different hues.

All of the processes involved in the formation of a cave and its decoration take an infinitely long time. Infinite, because there is no beginning or end to all cave processes. Each cave goes through a birth, where it is only a crack in the stone; growth, when it is made larger by erosion or solution; maturity, when it reaches its maximum size and is decorated with dripping formations; and death, when the formations become dry and the ceiling collapses, exposing the cave to light and making it a

Rock painting at the Doña Clotilde site in Albarracín, province of Teruel, Spain. The picture, done in red, shows a man leading an animal by a halter, and the stylized figures of men and of a tree with falling fruit.

A footprint shows clearly in this aboriginal petroglyph in Tching Rock Hole, near Cue in western Australia.

6. ABORIGINAL PETROGLYPH

gorge. These stages are occurring all the time, and each cave is at a different stage of its life. Any one of these stages might take as long as a million years or as short a time geologically as five thousand years.

Prehistoric Men in Caves

FOOTPRINTS MADE by prehistoric man in the cave of Pech-Merle in southern France have been covered with a thin film of calcite. This thin coating has preserved in stone the passing of some ancient explorer as he peered into the shadowy recesses. Archaeologists believe that these footprints were made about 15,000 years ago by the very artists who painted on the walls of this cave.

Among the many mysteries surrounding caves are the remarkable remains of the cave paintings found throughout the world. Some of

25. BUSHMAN PAINTINGS OF SOUTHERN RHODESIA

Bushman paintings, like these in the Matopos Hills of Southern Rhodesia, can be seen on cave walls from the Sahara all the way to the Cape of Good Hope.

the most famous can be found in Africa, China, Tibet, Australia and Europe. Some may be only a few hundred years old, such as those in the caves of the American Indian or the bushman's paintings of Africa, but many date back to the Ice Age and before. The most spectacular and remarkable remains of cave art occur in a small area of southeastern Europe near the Spanish-French Pyrenees. Over fifty caves in that region have evidences of cave art ranging from finger scribbling on the mud-covered walls to polychrome paintings which rival works of great artists.

These drawings were not just the idle work of bored cave dwellers. They were serious expressions of the artists, carefully drawn in remote passageways far from the daylight.

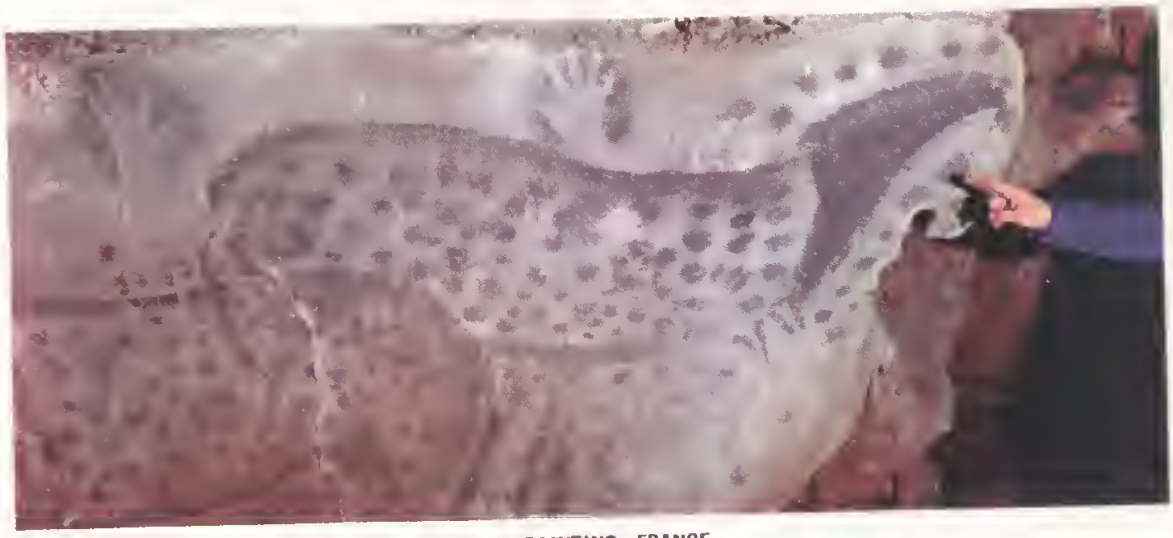
We can only guess what caused these men to make the paintings and to shape the crude clay images found on the cave floor. These men were hunters. They lived on the meat of the bison, reindeer, horse and bull. They hunted and killed for food and survived with the help of stone axes and wooden spears. They must have been very

Early Aurignacian rock painting of red and black hand silhouettes, at Gargas, France.

brave, but also very much afraid. Perhaps they considered paintings as another weapon to overpower those fierce enemies. The pictures were an expression of power: if man could capture the likeness and image of a beast, why not the beast itself?

Whatever the motive, it must have been very strong, because the paintings were not the work of a few artists. They span a period of 8,000 years—more than twice the time of our recorded civilization—and represent hundreds of individual artists.

Some bats live on a diet of fruit and palm nuts. They apparently use their sense of sight to a greater extent than do the insect-eating bats. The eye of this young dog-faced fruit bat glows in reflected light in the Batu Caves of Malaya.



15. CAVE PAINTING, FRANCE

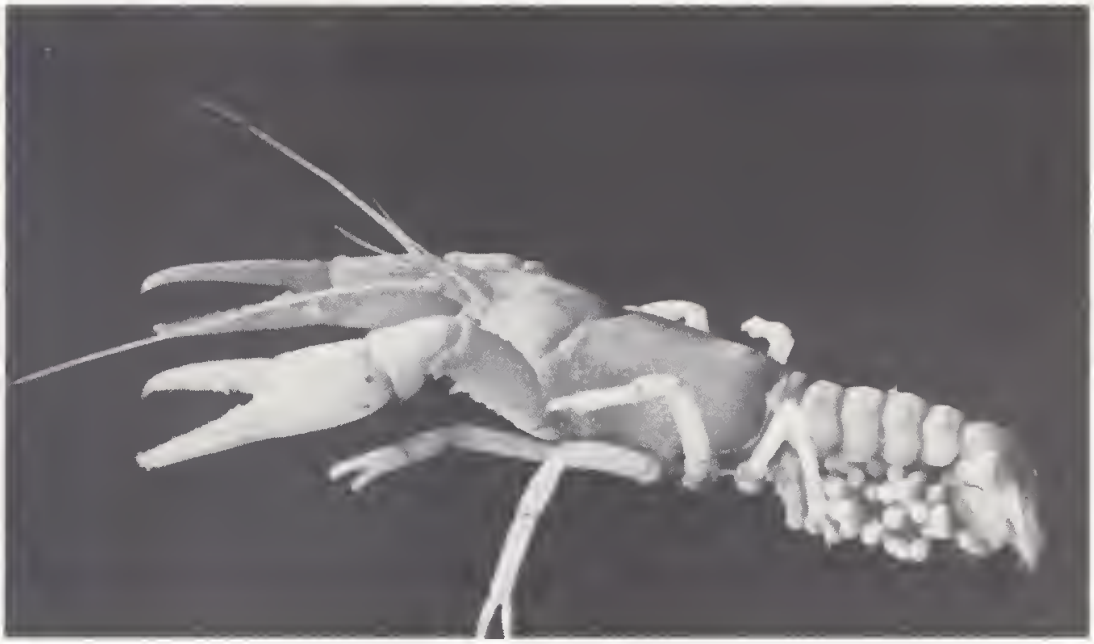
A primitive painting in the Pech-Merle Cave, in France, depicts a horse.

Pictures on Stone

LET US FOLLOW the footsteps of one of those men and try to visualize his thoughts and actions in the cave of Pech-Merle in southern France.

One day, 15,000 years ago, a lone man climbed a little wooded hill. He was carrying a torch lighted from a campfire. Half-way up the slope he stopped at a rocky ledge covered with moss and twisted roots. Ferns and bushes nearly hid the small opening in the ground at the base of the ledge. The man knelt down and, thrusting his torch ahead, crawled down a slope into a cave. A few feet within the entrance he stood up and held his torch high to look ahead—beyond the twilight zone. The floor ahead was smooth and dry and the walls and ceiling gray-white against the red-brown of the floor.

Intent upon his task and familiar with the way, he walked down a narrow corridor which soon broadened into an avenue twisting and turning ahead into the darkness. A few minutes' walking brought him



This three-inch-long white cave crayfish was found in a subterranean lake in the Ozark Mountains of Missouri. The female crayfish carries several dozen eggs beneath her abdomen until the embryos are well developed.

into a large room with a chaotic, boulder-strewn floor and a forest of stalagmites, columns and spiny ceiling only dimly seen in the light of his flickering torch. The man again held his torch high as he began a slow inspection of the rocks and walls around the edge of the room. He paused beneath the overhang of a towering slab of stone which had fallen from the ceiling in the remote past. The smooth, fractured side of the block stood like a wall in front of him. The near-white stone had been covered with sketches of animals, mammoths and oxen, smoothly drawn in charcoal before he was born. Turning away he climbed over the rough, slab-strewn floor searching for what only his eyes could see.

At last he paused in front of a shoulder-high sliver of rock only a few feet away from the wall of the cave, and he set his torch in a crevice close by to light the rock.

From a small bag tied at his waist, he took several reeds and sticks.

As the torch started to burn low he took another from a bundle he carried and lighted it. Blowing out the stub of the first torch, he watched the embers glow and die. Taking the charcoal stub, he stood before the odd-shaped rock and, with a few swift strokes, outlined in black the body of a horse. The eye of the artist had seen the outline in stone of the horse's head and in perfect proportion and symmetry he added the few strokes necessary to complete the shoulders, neck, body, rump and legs.

Then he took a lump of black paste and a smooth, slightly-hollowed rock from the little leather bag. Placing the paste on the rock, he kneaded it flat with his thumb. Reaching again into the bag, he found a green twig which he put in his mouth and began to chew with his strong teeth. As the twig became crushed and brush-like, he added his saliva to the black paste until he was able to dip the crude brush into what was now a blue-black paint.

Taking this paint brush, he traced over the thin outline, filling in with a wash the mane and rump. With thinner strokes, he drew in the legs and thighs.

Again going into his little bag, he brought out a short, hollow reed and folded leaf packet which contained finely crushed charcoal. Putting a handful of powder in his mouth, he took the reed and, bending close to the stone, he puffed little spots at random on the rump, flank and neck, revealing a dappled horse with a stone head.

With the drawing completed, the artist placed his hand on the rock above the back of the horse and blew a cloud of black dust completely over it. When he took his hand away, there was the outline of his hand in negative—the white rock showing through the black.

This signature by handprint, either by dipping the hand in paint and making a positive or by negative as described above, is one of the oldest known art methods. Handprints are found in African and Australian caves and in Indian caves in North and Central America, as well as in other places throughout the world. This means of identification seems to have been universal among primitive people.

But perhaps the strangest kind of handprint occurs in a small cave called Gargas in southern France. This cave has over 150 handprints made 18,000 to 20,000 years ago. The remarkable thing about these

prints is that all of the hands are mutilated, with one, two and sometimes even four fingers severed.

We do not know the reason for these mutilations, but anthropologists believe that certain primitive people used to cut off a finger at the joint when one of their loved ones died. This self-sacrifice is still practised today among the primitive people of New Guinea. A mother who loses a child will cut off a finger in her anguish and mourning and bury it with the child. What pathetic stories could be told of the hundreds of individuals who pilgrimaged to Gargas Cave to record their sorrow with their handprints in the dark recesses of this sanctuary.

These drawings were painted by members of the Luvale tribe in Southern Rhodesia on the walls of a mud-lined cave which they used as a granary.

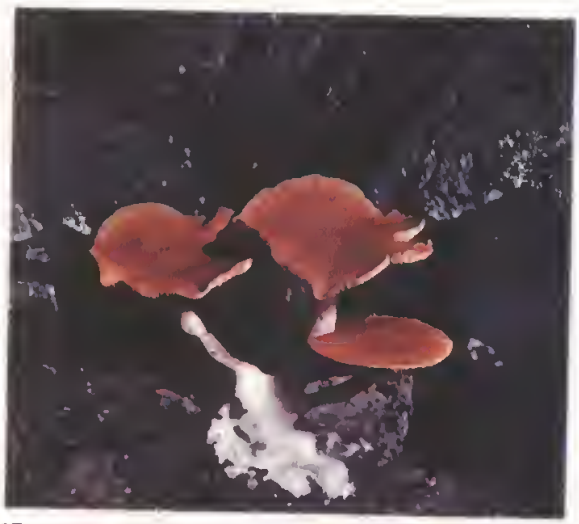
4. CAVE PAINTINGS OF LUVALE TRIBE

Not all pilgrimages to caves have been sorrowful, however. Caves have been used as places of pagan worship by strange early cults and, in more recent times, as hallowed places of some modern religions. Only a few miles from Gargas is the Grotto of Bernadette at Lourdes, where thousands of pilgrims of the Catholic faith have visited and worshipped. Jesus Christ is reported to have been born in a grotto used as a stable in Nazareth. Caves have been used by priests and monks as places of meditation and prayer throughout our recorded history.

More Recent Uses for Caves

IT IS ONLY in the past century that modern science has developed refrigeration for practical, everyday use. Before the making of artificial ice and controlled temperature conditions, caves were used for cold storage of vegetables and in the manufacture of wine and beer.

The early Romans brought ice to the tables of the emperor by swift runners from the ice caves high in the mountains. Many cities and industries were established because of the natural caves in the vicinity. The gorge of Cheddar in England gave its name to cheeses stored and



17. MUSHROOMS CAN GROW IN THE DARK

No green plants can grow in caves, but fungi and molds can if there is decaying wood or other organic matter present to supply the "food" they need in order to exist.

aged in the cool chambers of the caves. Even today shallow, dry caves in Puerto Rico are used as tobacco barns—the gray stone walls hidden by golden-brown streamers of tobacco leaves.

The common mushroom sold today for table use was developed from spore taken into certain French caves and cultivated for centuries. Today eighty per cent of America's table mushrooms come from abandoned mines and tunnels.

Many of the industries which used caves during their development have since abandoned them because of new technological methods. The mining of calcium nitrate for use as an ingredient of gunpowder flourished in America during the Revolutionary War, the War of 1812 and the Civil War. Thousands of tons of calcium nitrate dirt were taken from the caves of Virginia, Tennessee and Kentucky and converted into black gunpowder to feed the cannons of the day. Later, changes in requirements and improved chemical developments brought about easier and cheaper methods of obtaining this product.

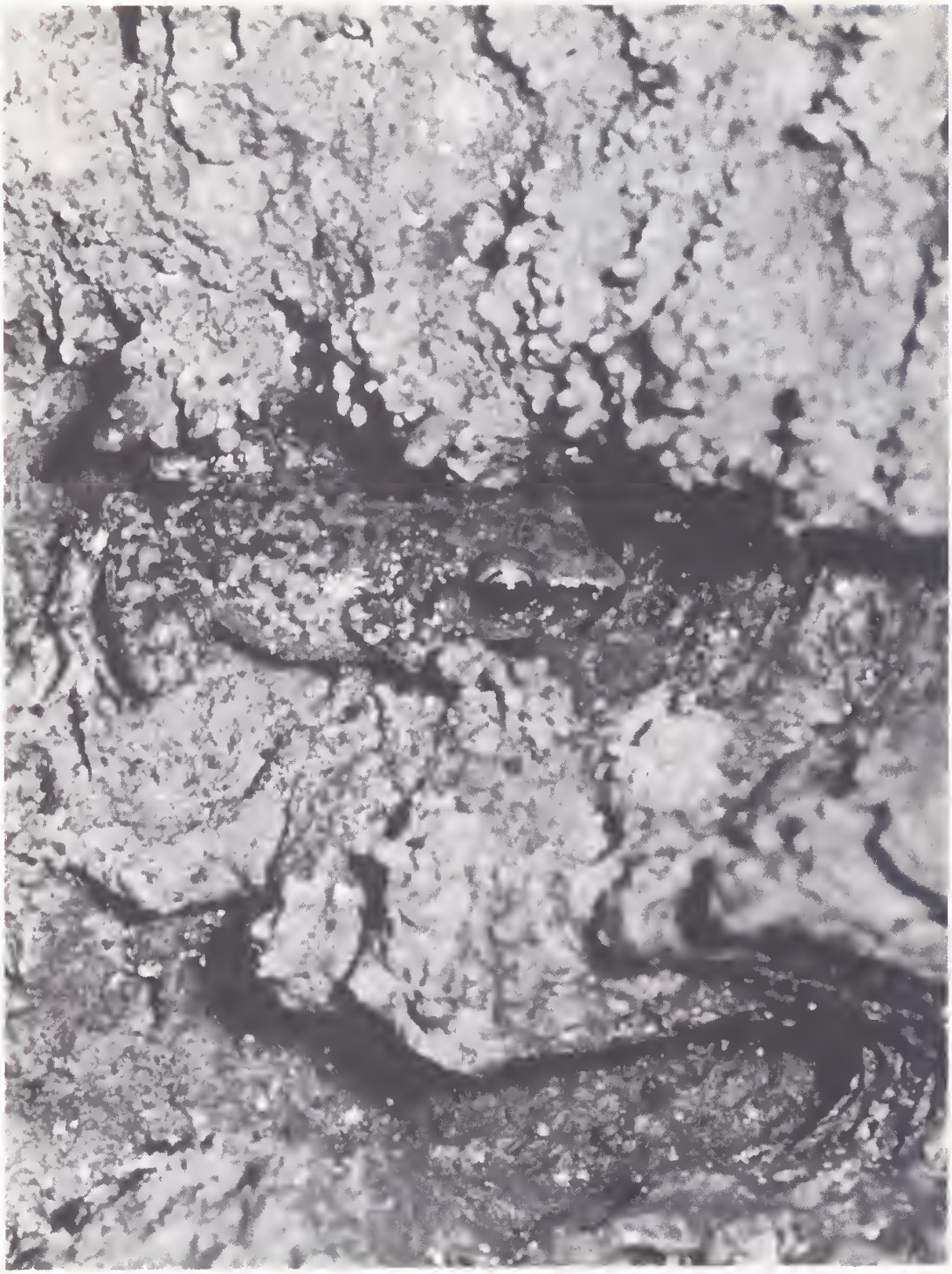
One constant use for caves over the years is as showplaces of nature's work. Hundreds of caves throughout the world are being shown to the public, lighted by electricity and displayed in a manner never anticipated by the early explorers. The owners of show caves—some of them governments—try to exhibit them as naturally as possible by means of concealed lights on the most beautiful formations and features.

While most commercial caves are developed to provide an artistic, stimulating experience for the visitor, sometimes the presence of people and lights destroys the very reason for development.

Lascaux Cave in southern France has probably the most remarkable collection of cave paintings in the world. Discovered in 1940, it was immediately protected and soon exhibited to the public as a magnificent prehistoric art gallery. The paintings had been perfectly preserved for 15,000 years because of an almost stagnant air condition within the cave. The introduction of visitors, lights and traffic at once created a ventilation problem. The French government installed an air-conditioning system at the cave entrance to maintain constant temperature and humidity. The demand to see this now-famous cave became greater and the traffic increased. Soon green algae started to form on the walls and began to obscure the paintings. This so alarmed the scientists and protectors of the cave that today it is closed to all visitors indefinitely.

The Fate of Cave Creatures

ANOTHER PROBLEM CAUSED by commercialization is that the natural pattern of life for the creatures which live in a cave may be dis-

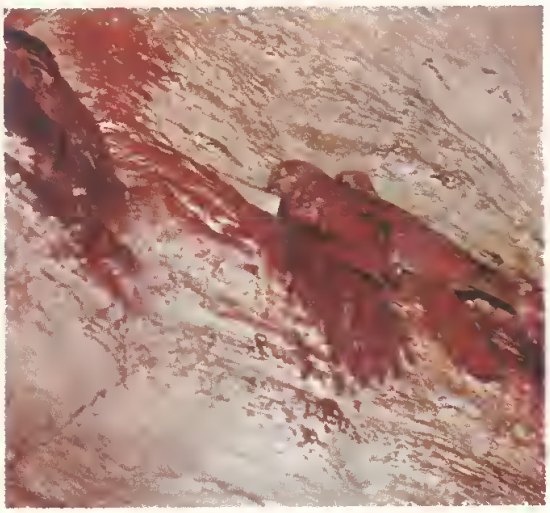


The noisiest of cave dwellers is this little frog, whose call can often be heard in caves in central Texas. Finding the ventriloquist is another matter, since it is protectively marked and creeps into crevices to hide.

turbed. Sometimes people who are eager to show the unusual features of a cave change the environment by adding lights; and these lights, plus the noise and traffic of people, cause the creatures which live there to disappear.

Such a cave is one called Adelsberg in Yugoslavia. This famous cave has been exhibited to tourists since 1830. Originally part of the tourist trip was by boat, and visitors could buy the unique cave creatures which lived in the water. These were blind, pink salamanders of a species called proteus, with external gills and visible internal organs. As a result of the sale of this "man fish" by guides, they are nearly extinct today. Only a few specimens survive from what was once a huge population.

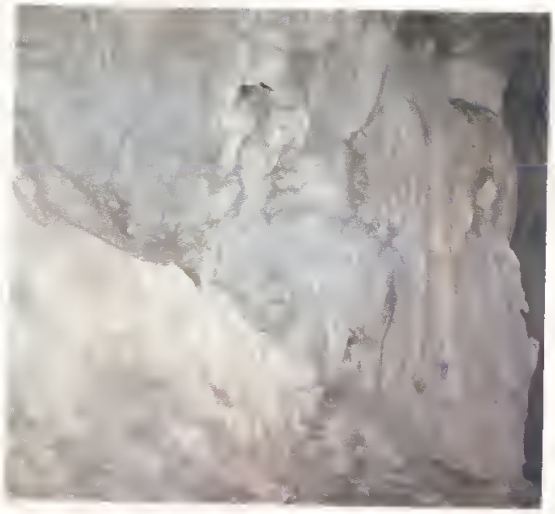
Another cave creature nearly driven to extinction is the Venezuelan guacharo, or oilbird. This large brown bird, which is the size of a chicken and has a three-foot wingspread, was first reported by the famous naturalist, Alexander von Humboldt, as he journeyed through Venezuela in 1799. Guacharos (the name means "one who cries" in the Indian tongue) lived in a large cavern in north-east Venezuela. A large colony of birds numbering in the thousands spent the daylight hours deep within the cave and went out at night to feed on palm nuts and fruits.



22. CAVE-DWELLING GUACHARO OR OILBIRD

The guacharo, or oilbird, is a partial cave dweller found in Trinidad and Venezuela. It roosts and nests in caves and secures its food outside the cave.

The Batu Caves are an example of the extensive limestone formations found in tropical Asia.



8. INSIDE BATU CAVES, MALAYA

These strong fliers would go many miles a night to feed, returning before dawn to nest in the cave.

In the spring of each year the young birds hatched, and for six weeks were fed and tended by the parent birds in their bowl-shaped nests high on the walls of the cave. Just before the young were able to fly, the Indians of the region used to go into the cave and, using long poles and platforms, climb up and knock the young birds out of the nests. These young birds—now almost as heavy as the adults—had stored a thick layer of fat in their bodies. The Indians killed the birds, took this fat and rendered out the oil in huge kettles. This almost pure oil was greatly prized by the Indians. Humboldt watched this slaughter and recorded the methods used by the Indians in capturing the helpless birds.

Today the guacharos are protected by the Venezuelan government; the present colony in Guacharo Cave numbers about three thousand. After studying these birds, scientists have discovered that they fly in the dark using a sort of sonar. They send out sound signals as they fly and, as these sounds bounce back off the walls, they know where obstacles are.

Another industry involving cave dwellers is still active today in some

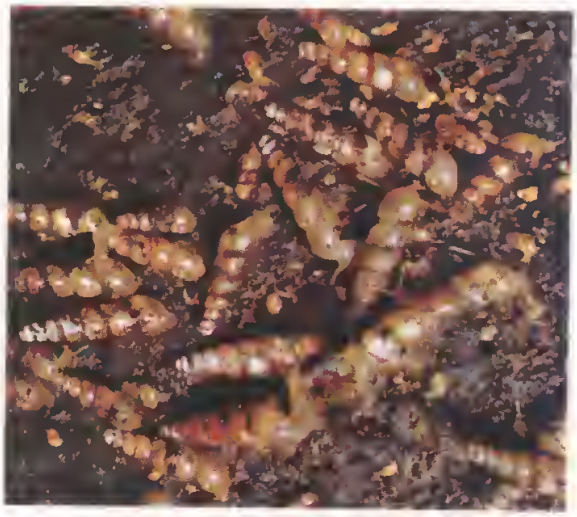
of the caves of Borneo. The nests of cliff swallows, which live in great numbers in certain caves, are prized as a table delicacy by the Chinese. Niah Cave in North Borneo is the home of nearly three million birds. Here twice each year after the young birds have left the nests, the local people climb two-hundred-foot poles to knock down the nests and collect them. This industry has existed for generations; certain portions of the cave ceiling are "owned" by various families, and the right to collect the nests is passed down from father to son.

Sometimes the development of a cave does not interfere with the life cycle of the cave creatures; then visitors can see the unusual natural inhabitants.

One of the most spectacular displays can be seen in Waitomo Cave

An inch-long grub, the New Zealand glowworm, inhabitant of Waitomo Cave, shines and shimmers to attract tiny midges which live in the mud of the river below. Long webs, sticky with mucus, are the fishing lines for these creatures. When a midge is caught, the glowworm draws up the line and has the midge for dinner.

These cave snails found in the Batu Caves of Malaya are only one form of wildlife in this rich area. The caves also abound with insects, reptiles and bats.



21. CAVE SNAILS IN BATU CAVES, MALAYA

in New Zealand. A boat takes visitors along an underground lake, silent and still, to a long tunnel deep within the earth. There the boat is anchored and all the lights are turned out, while the guide asks everyone to be still and watch the ceiling. In a few moments, little points of light begin to appear and soon the entire room is lighted from the glow of tiny star-like objects. This is the famous glowworm room—the home of thousands of tiny larvae of fungus gnats. This inch-long, luminous larva spins a sticky web and hangs from the roof of the cave to attract small insects which live in the underground stream.

We have mentioned only a few of the hundreds of thousands of caves that are found all over the world. Many of these caves are visited only rarely by man, but nearly all of them have some sort of life within them. Some species depend on outside sources for food and merely use the cave as a home. Others spend their entire life in the cave and depend on food brought in by water or other animals. Still others exist upon their fellow cave creatures. Thus we sometimes have a nearly complete closed food-chain environment in a single cave.

Because some of these caves are rarely visited by man, the natural balance of nature is not upset and speleologists (scientists who study caves) can find there a natural laboratory in which to study.

New caves are being discovered every day by people who have the interest and curiosity to seek out these chambers so slowly and carefully fashioned by nature. These people, called spelunkers, enter caves to explore, discover and study the underground courses of the twisting corridors and tunnels. They often discover beautiful rooms and fragile formations never before seen or photographed. Explorers always try to avoid any damage to caves and take with them all evidences of their visit. Many organizations throughout the world are dedicated to the

Skulls and skeletons of extinct creatures trapped in caves give scientists a picture of prehistoric life and climate.

26. SKULL OF EXTINCT JAGUAR

protection of caves and their life. Their philosophy, expressed by the statement, "Take nothing but pictures; leave nothing but footprints", will help assure that these natural wonders will be preserved for future generations to see and enjoy.

This brief glimpse of what can be found in some of the famous commercial caves of the world may have aroused your curiosity about the undeveloped, wild caves found in America. The author, a speleologist and confirmed spelunker, has visited hundreds of caves in the United States and Mexico. What are these caves like?

No Place to Be Without a Light

THE FIRST TIME you explore a wild cave, with your way lighted only by the carbide lamp on your helmet or "hard hat" and the flashlight in your hand, you will be deeply impressed by at least one fact about caves. They are really *dark.*

The darkness is absolute, complete, overwhelming. Sometimes during the tour through a commercial cave the guides turn off the lights momentarily—in a convincing demonstration that the inside of a cave is darker than the darkest night. In some caves there are minerals which are phosphorescent and glow in the darkness like stars.

Early man competed for the shelter of the caves with the giant cave bear, whose bones can be seen here. *Ursus spelaeus,* now extinct, was larger than our grizzly bear. Claw marks made by these animals can be seen eleven feet from the floor in some European caves.

The common little pipistrelle bat likes to hibernate in the comparatively warm (54° F.) caves of New York State in the wintertime. This little group will spend the winter upside down, not minding the condensation that will cover their fur and make them shine in the light of the spelunker's lamp.

Caves Seem Cool in Summer, Warm in Winter

ALTHOUGH IT SEEMS hard to believe when you visit a cave, the temperature will be the same summer and winter. There are few exceptions to this rule. In ice caves, already mentioned, it may fluctuate over a year's time, remaining below freezing through most of the spring and summer. Caves with very large entrances may be affected by winds sweeping a great volume of air into them, and so vary considerably from day to day. But as a rule you can count on the temperature of both air and water within a cave being about the same as the average annual temperature in the same region.

There are no seasons underground; no hurricanes or tornados; no snowstorms or hot spells. It is this freedom from the weather, especially from extremes of heat and cold, which makes caves a haven, a monotonous but efficient sanctuary for many forms of life that could not endure the harsher environments above ground.

Of course the absence of light in caves immediately eliminates the possibility of green plants growing there. And since animal life directly or indirectly is dependent on plant life for food, the absence of sunlight is an almost insurmountable obstacle to the development of abundant subterranean life.

The trader rat is a native American rodent with long whiskers and a furred tail. Its curiosity and collecting habit are responsible for many legends and stories of the West. Various species occur widely in the United States.

To be sure, plants without chlorophyll—some bacteria, molds of many kinds including *penicillium* (from which penicillin is derived) and fungi—do grow in caves, for they have no need of light, but require only some dead, decaying matter from which they can draw nourishment. Leaves, branches and logs, washed or fallen into a cave, provide everything in addition to moisture that these non-green plants need. This debris, augmented by the droppings of bats and other animals, generally is all that sustains whatever populations of animal life dwell here permanently in darkness.

They Run "Upstairs" for a Snack

NOT ALL CAVE DWELLERS find their food within the caves. Pack rats do not, and they are among the most widespread troglodytes (another word for cave dweller, used chiefly to describe African and Asiatic peoples who built cities underground).

Pack rats leave the caves at night in search of loot, cedar bark or other material for nest building, and food. Any article that "catches their eye", if it is not too big to carry off, is transported to their underground "museum". Sometimes they exchange a walnut, an acorn, or a

18. AYER'S ROCK BAT CAVE, AUSTRALIA

This bat cave is one of several occurring at the base of Ayer's Rock in the middle of the Australian continent. The cave is wind-formed in the 230-million-year-old red sandstone.

stick of wood for the article they appropriate—a habit which has led to their being called "trader" rats by many people. They are known also as cave rats, but they frequently build their nests outside of caves. This is particularly true in parts of the western United States where caves may be scarce.

Young pack rats might be mistaken for deer mice because of their white underparts and their general resemblance to the smaller rodents. Of course mice do not grow into rats. Pack rats, by the way, are American "natives" and are unlike and unrelated to the destructive Norway rat, which has become a plague in many U.S. cities, and which was introduced from the Old World.

World Champion Sleepers

NO MAMMAL—no furry, warm-blooded animal—is a permanent cave dweller. Yet there are some mammals which spend half a year, even two-thirds, in a cave asleep! You've doubtless figured it out—we're talking about bats which *hibernate* in caves. Depending on the species of bat and the severity of the winter, they spend from three months up to eight months just "sleeping".

During warm weather, tens of millions of bats venture forth at dusk to sweep the air for night-flying insects—mosquitoes, moths and beetles for the most part. By the end of summer the bats have accumulated thick layers of fat beneath their fur. Though some kinds of bats migrate southward and remain active all winter, most bats that roost in colonies head for caves or other protected wintering areas. Their next meal may be six months away, but their stored-up fat will provide the small amount of energy they need during their long dormant spell.

Caves Have Just What It Takes for a Long Nap

CAVES MAKE IDEAL winter sleeping quarters, since in order to hibernate successfully an animal needs darkness, quiet and a constant temperature above the freezing point. Caves have everything to offer.

A hibernating animal's temperature drops as low as its surroundings,

In regions where cold weather eliminates the bat's food—flying insects—most species of bats fatten up before winter sets in and then become dormant. Caves offer dark, quiet conditions plus an even temperature of between fifty and sixty degrees Fahrenheit—ideal for these hibernators.

so the cooler the cavern the slower the bat burns up its stored fuel or energy. When disturbed, a bat arouses speedily. Generally within a few minutes its temperature has risen to 90 degrees or higher and it is ready to launch itself into the air and fly away. But all this activity results in using up energy at a much faster rate and if the fat reserve fails to last through the winter the bat will starve to death.

In the South, bats can be found in caves in the summertime. In the North they rarely hang in caves except to hibernate. What the signal is that sends bats heading for the caves no one knows, but by October

clusters of bats can be found hanging head down, their tiny toes clinging tirelessly to the limestone walls or ceiling, sometimes even to a smooth stalactite or a slick patch of flowstone.

How Can a Bat Navigate in the Dark?

HOW DOES A BAT find its way through the uncharted labyrinth of a cave to the particular spot where it will hang for the next half year? And how does it pursue its insect prey in the night and at the same time manage to avoid the sweeping branches of the forest or the city's network of wires, poles, radio and TV antennas, not to speak of its patchwork quilt of buildings?

Scientists long believed that bats possessed a network of sensitive nerve endings in their membranous wings, and that "compression of the air" as they neared objects in their flight gave warning of danger. For 200 years scientists had experimented with bats and knew that bats could avoid wires and other obstacles in their path, even when blinded!

Then two Harvard scientists went a step further. With supersonic recorders they proved that bats were giving off high-pitched signals

Though this bat may seem in danger of colliding with the cave formation, echoes will warn it in time for it to change its course.

24. BATS NAVIGATE BY SONAR

Mother bats sometimes carry their babies on their chests while they go out in search of food. This baby serotine bat clings to the fur of its mother as they dart over the English countryside. There is no second chance if the baby slips.

inaudible to man. To discover whether hearing was involved they plugged the ears of the bats. When released in the laboratory these "deaf" bats blundered into obstacles.

Were the supersonic signals important? To find out, the scientists muzzled the bats. When their mouths were taped shut but their ears left unobstructed, the bats were still unable to navigate successfully. Without doubt the high-pitched signals they produced guided them by

bouncing back from anything that lay in or near their path. It was definitely an echo from an obstacle which revealed its presence and thereby enabled these bats to navigate without disaster.

"Echo-location" the scientists called it, and likened it to the cane tapping a blind man uses for the same purpose, locating objects by the echoes of his tapping.

Most Bats Are Insect Eaters

BATS IN THE UNITED STATES, with the exception perhaps of a few rare species, are exclusively insectivorous. In some of the southwestern border states an occasional fruit bat is found, but most fruit-eating bats live only in tropical regions. The world's largest are the "flying

The least brown bat on the right weighs only an eighth of an ounce, a small fraction of the weight of the big brown bats, largest common bats in North America. Both are hardy creatures, being able to hibernate where air temperature is only a few degrees above freezing.

MAJOR WORLD CAVES

1 Mammath Cave, Kentucky, U.S.A.
2 Carlsbad Caverns, New Mexica, U.S.A.
3 Hallack Cave, Switzerland
4 Gaping Ghyll, Great Britain
5 Pastajna (farmerly Adelsberg), Yugaslavia
6 Dent de Cralles, France
7 Bustamente, Mexica
8 Aven d'Orgnac, France
9 Eisriesenwelt, Austria
10 Cacahuamilpa, Guerrera, Mexica
11 Gauffre Berger, France (warld's deepest cave, 3,000 ft.)
12 Waitama Caves, New Zealand
13 Ría Camuy Cave, Puerta Rica
14 Guachara Cave, Caripe, Venezuela
15 Lanquin Cave, Guatemala
16 Lascaux, France

9
5
12

foxes" of the south-west Pacific and south-east Asia. It is an interesting fact that some species have a wingspread of more than four feet.

Unlike birds, a bat builds no nest. A female bat moves about with her single offspring clinging tightly to her with its teeth and toes. Usually, however, when the mother bat flies forth at night to feed, she leaves her infant hanging from the roof of the cave. When she returns she seems to have no trouble finding her own baby. Occasionally cave bats have twins.

Baby Bats Live on Milk for Nearly a Month

YOUNG BATS are all very much alike. They are born with their eyes closed and without fur. A soft growth of hair quickly appears, and in a few days their eyes open. Nursed frequently by their mothers, the baby bats grow rapidly on their diet of milk, and within three to four weeks are fully furred, flying, and quite able to find food for themselves.

When fruit bats feed upon flesh-covered seeds of various tropical trees, the softer material is quickly digested but the hard seeds pass through the bat's digestive system unaffected. After lying for a period of time on the damp floor of the cave where they have fallen, the seeds will sprout, and many a cave explorer in the tropics has located a roost of fruit bats high overhead by discovering on the floor beneath them a little forest of pale, skinny seedlings. There is food enough within the seeds to enable them to grow to a height of two or even three feet. But without sunlight the seedling trees are doomed, and soon they topple over and die.

Carlsbad Is Notable for Size, Beauty and Bats

THOUGH CARLSBAD CAVERNS, in New Mexico, is a relatively recent addition to the national park system of the United States, its unsurpassed size and wealth of formations have attracted millions of tourists. Cowboy Jim White, who struggled for years to bring the magnificent cave to the attention of the public, claimed that a great bat flight led him to the discovery of its entrance.

A vampire bat has only a few teeth, but its razor-sharp incisors enable it to slash the skin of bird or mammal. Then the vampire laps up the blood which oozes from the wound. In the process a rabid bat could infect its victim with rabies. Vampire bats are tropical species which have never been found north of the U.S.-Mexican border.

The extraordinary outpouring of bats can still be seen on summer evenings. As the sun disappears, bats roosting in the bat cave, half a mile off the tourist routes, begin to fly. First hundreds, then thousands of bats drop from their daytime roost and head for the yawning entrance. Some years ago, an estimated nine million bats streamed out of the entrance in a seemingly solid column. The flight is now much reduced in numbers, but it is still a sight worth waiting for.

3. MOTH HIBERNATING IN A CAVE

An inch long, this unusual pink moth may hang from walls or ceiling or it may rest on a ledge, as shown here.

They Drink Before They Eat

THEY FLY STRAIGHT to the Pecos River, a few miles away. There they swoop down to the surface, scoop up a few mouthfuls of water and then scatter to spend the night in pursuit of insects. Before dawn they whirl down into the cave entrance and return to their tremendous roost in the bat room, there to pass the "daylight" hours in absolute darkness.

Vast quantities of guano have accumulated here through the uncounted centuries since the bats began to roost in Carlsbad Caverns. Starting in 1901 this deposit was systematically mined for fertilizer and up until the time the national park was established a half-million dollars' worth of guano had been removed.

Caves Were Important in Wartime

MANY OTHER CAVES in the South and South-west of the United States have been the scene of mining operations. Both the guano and certain earth deposits contain enough nitrate to provide a source of chemicals for explosives.

During the War of 1812 large quantities of cave earth were collected and soaked in special tubs or vats. Calcium nitrate was removed and used in the making of gunpowder. Again in the Civil War, when the Confederacy was cut off from overseas supplies by the Union blockade, caves provided the nitrates needed to carry on the war.

Fresh guano is made up of brownish droppings about the size and consistency of partly cooked rice. In the Carlsbad bat room I have sunk knee deep in the mountain of guano which covers the floor of this

11. GUANA AND BAT BONES

Three bat skulls and one entire skeleton can be seen on top of the guano. The long finger bones which support the wing membrane fold together very much like umbrella ribs.

seldom visited portion of the cave. Scattered over the surface and throughout the guano are thousands of skulls and skeletons of the guano bats, or free-tailed bats, as this species is known.

The flesh and fur are quickly stripped from any bat that falls, dead or alive, from its perch 300 feet overhead. A myriad of dermestid beetles, and other flesh- or fur-eating insects, spiders and other minute creatures earn their living in this way. Guano, and dead bats, are the beginning of a "food chain" that encompasses almost all of the life within the cave.

Trapped in a spider's web, this millipede has fallen victim to the cave spider, *Meta menardii*, a species often encountered in cellars and similar cave-like situations.

Lots of Life in a Tropical Cave

I WAS PARTICULARLY conscious of this "chain" in a cave I visited in Guerrero, Mexico. Here, too, it was guano that provided food for a fantastic population, starting with hundreds of small white-shelled snails and including, no doubt, the hordes of two-inch-long roaches that covered the walls of the room where a colony of bats roosted. Probably a number of four-footed creatures fed on the snails and roaches, and on any bats they could reach.

Where bats are scarce or absent, other cave life also is likely to be scarce. In some large Kentucky caves you can walk for a mile without seeing any sign of life. But if you strayed from the familiar route and were to slip on some wet clay or stumble over a projecting rock and fall to the ground, you might get close enough to discover tiny brown beetles, minute white spiders and pale millipedes—"thousand-leggers"—scurrying out of your way, especially if you dislodged a damp bit of driftwood, carried into the cave in time of high water.

Monsters in Miniature

IT IS ONLY when you get down on hands and knees, or lie prone, that you are likely to spot creatures as small as the blind cave beetle, for instance. Although it is only a quarter-inch long, this little insect is doubtless a terror in its own lilliputian environs, for it is armed with jaws which must be very powerful. One looks in vain for eyes. The beetle has none, nor does it have optic nerves. Even the optic lobe of the brain disappeared ages ago. Blind beetles have been cave dwellers for a long, long time.

Most kinds of cave crickets, on the other hand, might be found as readily in the cellar of a country farmhouse, or in a cabin in the woods. They live under rock ledges out of doors, and under logs. Anywhere, that is, where they can find cave-like conditions—darkness, and cool, moist atmosphere.

Caves, naturally, are fine for crickets. I remember one "wild" cave in Texas where I saw thousands of them. The tremendous size of the cricket population was so well known locally that fishermen came into

13. A BLIND CAVE BEETLE

Hard to see because it is only a quarter of an inch long, this insect can be found in many southern caves.

In almost every cave a few of these insects can be found. Their antennae are much longer than their bodies.

9. A CAVE CRICKET DOESN'T CHIRP

the cave regularly to collect the insects for bait. Actually the graceful insects with the very long antennae are really grasshoppers. They are silent, unlike their somewhat noisy cousins, the true crickets.

As long as the weather is mild, many cave crickets wander out at night and feed on green vegetation. There is one type of pale cave

cricket, however, that never ventures outside, but spends its whole life deep within the caves.

Insects That Spend the Winter Underground

As WINTER APPROACHES many insects enter caves to seek shelter. They remain there until the return of warm weather. Among those that escape from freezing weather in this way are mosquitoes, flies, fungus gnats, flower flies and several species of cave moths, the most conspicuous of which is an unusual pink one the scientists call *Scoliopteryx.*

Spiders such as those that live in cellars often spin their simple webs just inside caves. They are completely harmless, as are the familiar daddy longlegs or harvestmen which sometimes gather in seemingly hopeless tangles of long thin legs and tiny bodies. After all, since they have eight legs apiece, a cluster of 125 harvestmen would mean a thousand legs. That many jammed together on a square foot of cave ceiling creates quite a parking problem!

In the moulting stage, most insects are helpless against attack. This little cockroach, deep within Batu Caves, is protected by the darkness until he regains his strength and starts to forage for food. In the tropics cockroaches sometimes exceed two inches in length.

The daddy longlegs have the reputation of being the skunks of the cave world, giving off a distinctly noticeable and unpleasant aroma. Still more unexpected is the pulsating, wave-like "dance" they do when the spelunker brings his light close to them.

White, Eyeless Water-dwellers

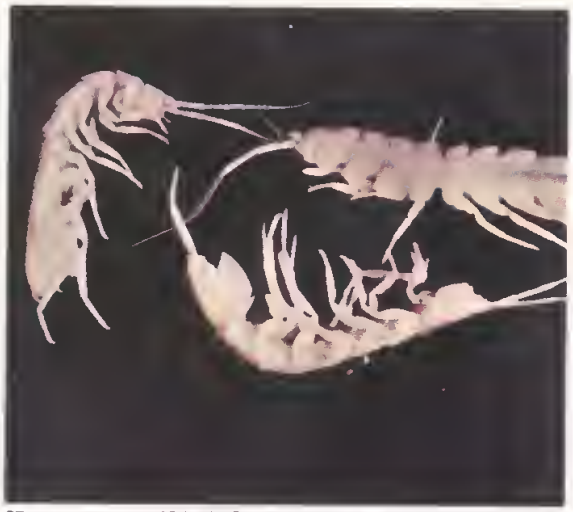
THE DRIER THE CAVE, the less animal life one can expect to find, while the wetter it is, the better is the chance for abundant and varied inhabitants. Best of all are the caves through which a stream flows constantly or where a passage leads down to a subterranean lake, which in many cases represents the water table.

Here, if you wait patiently, you may be rewarded by the sight of vertically flattened water fleas, or amphipods, and horizontally flattened isopods, a kind of aquatic pill bug, less than an inch long. These jointed-

2. CAVE-DWELLING EYELESS FISH

Eyeless cave fish are almost transparent. They are sensitive to tapping on the rock or flowstone, but not to other sounds. However, insects and other creatures which fall into the water create enough disturbance to attract the fish. This seems to be the way they get most of their food.

Cave waters are the home of these jointed-legged cousins of the crayfish. They are less than an inch in total length.



27. ISOPODS LIVE IN WATER

28. PLANARIANS FEED ON AMPHIPODS

Flatworms change their shape as they flow along. Some flatworms are found under rocks in springs and streams at the surface. This cave species is about a half-inch long.

legged little creatures resemble close relatives in the surface streams, but in caves they are generally white and eyeless.

Rarest find is a tiny cave shrimp known from only a few caves in the United States and Mexico. Very similar to its marine relatives in appearance, the cave shrimp is so transparent that I discovered its presence

29. AMPHIPODS ARE "WATER FLEAS"

Amphipods are flattened vertically. They seldom are more than a quarter-inch long, and are hard to see as they "bounce" through the water.

only after my flashlight had cast the shrimp's shadow on the bottom of a cave pool.

Nothing Goes to Waste

IT IS DIFFICULT to say just what these tiny cave inhabitants eat. Undoubtedly they sometimes devour each other. Certainly nothing that dies remains whole for long.

Whenever a cave stream flows over a deposit of guano, a nutritious "soup" seems to be formed. Living in such a situation in a bat cave I visited in Oklahoma was the most remarkable population of planarians and isopods I have ever seen—the water swarmed with them! Thousands, probably tens of thousands, lived there.

When surface streams disappear into a sinkhole and flow underground for some distance, familiar species of fish, crayfish and other forms of water life from above ground may be trapped there. Often they manage to survive for years but fail to reproduce in their new environment.

Some cave streams flow directly or indirectly into surface lakes or

streams. When this happens cave species generally remain in the cooler, darker cave waters, while eyed species as a rule stay in the lighter, warmer waters. One exception is the fish called the "millers thumb" which often enters caves and swims far upstream.

Brown Crayfish and White Ones

In Kentucky one type of crayfish, although it is brown and possesses normal eyes, has successfully become a cave dweller. Comparison with closely related species on the surface reveals, for one thing, that the cave variety has longer antennae. Being longer and possibly more sensitive, these "feelers" probably help compensate for the creature's inability to make use of its sense of sight.

Among the most striking of the denizens of the underworld are the dozen or so species of white blind crayfish. Found from the Ozark

Rock painting in Gasulla Ravine, province of Castellan, Spain, showing a procession of warriors, or perhaps a cult-dance.

Mountains in Missouri to Florida, their absolutely white bodies and slender appendages give them an "out-of-this-world" look.

Happy Haunts for Salamanders

AT ABOUT THE POINT where the states of Tennessee, Georgia and Alabama meet, a large underground river flows from beneath the most massive cave entrance in the country—Nickajack Cave. It was in and around this entrance that the green salamander was first found; but it is in tiny cave-like corridors between sandstone blocks in the mountains of West Virginia that this rare salamander has most often been encountered. Green salamanders have been successfully hunted only at night, when the slender amphibians come to the entrances of their burrows to look for insects, worms, or smaller salamanders to eat.

Above ground it is nighttime that brings lower temperature and higher humidity—conditions suited to the needs of salamanders. When it rains at night these moist-skinned amphibians come out of their burrows to roam around the forest floor. Caves provide similar conditions twenty-four hours a day, weeks on end, so it is not surprising that these amphibians so often are found there.

Sharp Eyes Needed

MOST SALAMANDERS are only a couple of inches long, so tiny that cave explorers crawling through the darkness rarely notice them. In Kentucky's well-illuminated Mammoth Onyx Cave, however, the guides every day passed close to a certain fluted column. On one trip an alert guide spotted something shiny in one of the crevices. It turned out to be a small cluster of white eggs, each less than a quarter of an inch in diameter. They were guarded by a salamander half curled around them.

The guide showed me his discovery a few days later. I recognized the species as the zigzag salamander and realized that this "nest" was a scientific first! The eggs had never been seen before. The guides faithfully kept track of developments, and learned, for instance, that it

This common salamander, *Plethodon glutinosus,* rarely deposits her eggs where they can be found. Here in a cave in the southern part of the United States, the female guards her eggs for ten weeks until they hatch, then keeps the tiny salamanders herded together for several more weeks.

takes three months for the eggs to hatch in the cool cave atmosphere. On the earth's surface a closely related salamander lays its eggs in damp cavities in logs or under stones. Here higher temperatures prevail and the eggs hatch in only two-thirds of the time it takes the cave dweller's eggs to hatch.

Like the slimy salamander, whose eggs were recently discovered by

5. EYED CAVE SALAMANDER

This eyed cave salamander lives in the "twilight zone" near the entrance to a cave. This particular specimen was found in Italy.

a spelunker in a Georgia cave, the zigzag salamander herds her offspring together once they hatch and keeps them close to her for several weeks, a very unusual performance among the "lower" animals, where parental care is virtually unknown.

Concentrated in Caves

THE SLIMY SALAMANDER is found in many areas of the United States, including areas where caves do not exist. But you might consider it almost like looking for a needle in a haystack to go hunting for it under logs and stones in the woods and mountains. At certain seasons, however, salamanders appear in caves by the scores, even by the hundreds. At such times we have a fine opportunity to study the life history of these creatures, provided that the colony can be protected from curio collectors and from some young naturalists who mistakenly think that a specimen in alcohol is more instructive than a living animal.

The salamanders we have mentioned so far are not strictly cave dwellers. That is, they show no particular fitness or adaption for cave existence. Their eyes are like the eyes of other salamanders whose activity is limited to nighttime forays from their sub-surface retreats.

Only a few species of salamanders spend their entire lives in caves. They differ from their surface-bred relatives in a number of ways, most obviously by their lack of pigmentation, and by being partially or completely blind. The best known of these blind cave salamanders lives in caves in the Ozark Mountains of Missouri and Arkansas.

A Blind Salamander That Can See!

THE STRANGEST THING about the Ozark blind cave salamander is that the immature form, the larva which dwells in the water, has eyes. It can see. Furthermore, the skin of this blind cave salamander sometimes has, surprisingly enough, dark-toned patches.

These larval salamanders often live in springs where they are exposed to at least some light. During larval life they "breathe" through gills instead of lungs. These gills disappear when the salamander "grows up", or as the scientist says, goes through a "metamorphosis". Great changes occur at this time.

One might expect that lungs would develop and take over the job of exchanging oxygen and carbon dioxide, but this does not happen. The adult is lungless, like a good many other salamanders. Gases pass through its moist skin, oxygen being carried directly to the capillaries just beneath the surface, and carbon dioxide passing outward into the moist air. This can happen only so long as the creature's skin remains moist.

Even more remarkable are the changes that go on in the animal's eyes. First eyelids begin to develop, then overlap and grow tightly together. Finally the internal structure of the eye itself begins to break down. Now the salamander is really blind.

Only One Kind of Blind Salamander "Grows Up"

ONLY A FEW other types of blind cave salamanders exist in the whole world. First to be discovered and famous throughout the world is the olm, known as proteus, found in caves north and east of the Adriatic Sea in Yugoslavia. The Ozark species is the only blind sala-

mander which metamorphoses; the others keep their feather-like gills throughout their lives, remaining in a sense "permanent larvae", that is to say creatures which do not completely "grow up", although they do, of course, reproduce.

Another species is the Texas blind cave salamander, whose discovery in 1891 was sudden and dramatic. A well being drilled at a fish hatchery in San Marcos, Texas, produced water at a depth of 300 feet. When water gushed to the surface it carried upward a number of strange, slender white salamanders three to four inches long. They were a great scientific curiosity and much in demand for museum collections and laboratories.

Over a period of many years the odd, awkward-looking creatures kept coming to the surface. Some were encountered in nearby caves which

Rock painting of animals and men, painted in red, brown and white pigments, Barranco de las Olivanas, Spain.

penetrated deeply enough into the earth to reach the same underground reservoir that the artesian well had tapped. Over the years, however, they were found with less and less frequency. In recent years so few of the salamanders have been seen that scientists in Texas have taken steps to protect the remaining population of these unique sightless salamanders.

Fish Without Eyes Swim in the Sunless Waters

MOST FAMOUS of cave creatures are the blind fishes found in scattered caves from Tennessee to the Ozarks. The first such eyeless fish were discovered in Mammoth Cave, Kentucky, and scientists came from all over the world to see them.

The most common species, the Kentucky blindfish, is small, seldom measuring much over three inches, and it is so pale that one can almost look through it. As a matter of fact, the fish's internal organs can be seen quite plainly. The fish has what at first glance look like eyes; however examination shows them to be only lumps of fatty tissue. Scattered over the fish's head are rows of tiny bumps, containing highly sensitive nerve endings.

The condition of growing up without losing larval features such as gills is called *neotony*.

23. TEXAS BLIND SALAMANDER RETAINS GILLS

Every environment in nature usually involves a food chain; here in Batu Caves, Malaya, a cave centipede feeds upon a cockroach captured in its search of food for survival. Food is brought into caves by water and animals, and decaying matter supports a host of small creatures.

Blindfish can detect vibrations in the water instantly, but sounds, even very loud ones, make no impression on them. When some of the fishes were captured by an ichthyologist in Indiana he transferred them to a large concrete basin just outside a cave. After watching them for many months he discovered a remarkable thing about the life of the blindfish and why the eggs or very small young had never been seen.

THE NATURALIST had noticed that instead of being back near the tail fin, the fish's vent or cloaca was far forward, just behind and below the gills. Then he discovered that as the fertilized eggs are laid they become attached inside the gill chambers, where they are carried for a full month until they hatch. Then, instead of swimming forth, they stay "under cover" within the fish's mouth for another month until they are big enough to be able to care for themselves.

Scientists wondered how this fish became blind. Did it lose its sight and its eyes because it had no use for them in the sunless caves? Or were its ancestors well along the way to becoming blind before they entered caves?

Scientists are almost sure that the latter explanation is the correct one. The nearest relatives of certain American blindfish, they point out, are weak-eyed species which live in dark swamp ditches or in even darker crevices under rocks. Depending little if at all on sight, such species would not be much handicapped if they were swept into a cave by a flood or by some other mischance. They would be able to find their food in the dark.

Gypsum crystals a foot or more in length gracefully decorate the walls and ceilings of some caves.

14. A GRACEFUL GYPSUM CRYSTAL

A Blindfish for Your Aquarium

THE DISCOVERY of "tropical" blindfish in a Mexican cave shortly before World War II was responsible for bringing such a remarkable thing as a cave-dwelling blindfish into the homes of thousands of fish fanciers. It led also to laboratory experiments which have made this finny creature the most studied and the most fully investigated cave inhabitant in the world.

All northern blindfish live in cold cave waters, whereas this was a warm-water species; for the first time it was possible to keep and breed them. In fact, so many have been bred in captivity that the Mexican blindfish may now be purchased at a very modest price.

Scientists who went to Mexico to study the fishes in their native haunts were astonished when they reached the cave to find not only the eyeless fish they expected but eyed ones also, and even some with small imperfect eyes.

Those with the largest eyes could not be distinguished from fishes that lived in the Rio Tampoan, a mile from the cave. But later, in the darkness of the laboratory "cave", the river fish failed to reproduce, while all grades of eyed and eyeless cave fishes laid eggs.

Though they admit that they still are "working in the dark", the experimental biologists are continuing to probe the mystery of how living things become adapted so as to permit survival in this world of perpetual night. There is still much to be learned.

Each year explorers penetrate into new caves, discovering new forms of cave life, uncovering fresh evidence of early man, and proving that caves are truly the portals to some of the world's greatest wonders.

MEL HUNTER